

## Message

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**From:** Walker, Stuart [Walker.Stuart@epa.gov]  
**Sent:** 2/9/2021 5:02:49 AM  
**To:** Sanchez, Yolanda [Sanchez.Yolanda@epa.gov]  
**Subject:** FW: Dissipation factor  
**Attachments:** WTC discussion of dissipation rate.pdf

Fyi, hopefully this will go around to everyone soon.

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**From:** Walker, Stuart  
**Sent:** Monday, February 08, 2021 11:58 PM  
**To:** Libelo, Laurence <Libelo.Laurence@epa.gov>; Fitz-James, Schatzi <Fitz-James.Schatzi@epa.gov>  
**Subject:** Dissipation factor

At our last meeting on Hunters Point there was a request for more information on dissipation rate that is an input parameter in the BPRG calculator and the World Trade Center (WTC) incident.

In section 4.3.8 in the BPRG User Guide (which I copied most of below with some yellow highlighting that is relevant to this discussion of dissipation rate) followed by some key language in the WTC document (which is also attached). The BPRG User Guide is at: [https://epa-bprg.ornl.gov/users\\_guide.html](https://epa-bprg.ornl.gov/users_guide.html)

### 4.3.8 Dissipation Rate Constant (k)

In some circumstances, the load of dust on a contaminated surface to which receptors are exposed may decline over time. Dissipation of dust may result from cleaning and transfer to skin and clothing. Different surfaces may be cleaned at different rates, and any dissipation rate used should consider a representative cleaning frequency. To determine whether dissipation is a factor at a given site, the site manager should establish whether a significant reservoir of contaminated dust is present. Such reservoirs may function as sources of dust and negate the impacts of dissipation mechanisms. In fact, indoor concentrations of contaminants may be enhanced above their original outdoor source levels after repeated transfer inside (Paustenbach et al.). The recommended first step in identifying the presence of a reservoir is to examine site history. If a waste site was created through disposal, deposition, or equipment leaks over an extended period of time, then the contaminant may have seeped deep into the surface. Porous surfaces such as cement or wood are also more likely to have subsurface contamination. When reservoirs are less likely to exist, such as at sites where contamination is the result of a single spill, dust cloud, or event, it may be more important to account for dissipation of surface loads. For fixed contamination in building materials or on material surfaces in the 3-D equations, the dissipation term is not included as dissipation is not expected.

The recommended default value for the dissipation rate constant, 0.0, assumes that a contaminant reservoir is present. This variable is adjustable in the recommended BPRG calculator. If a dissipation rate constant is used, it is generally assumed that the dust was deposited as a one-time event (i.e., dust cloud). Also, if a dissipation rate is applied, it is assumed that it is applicable from recommended BPRG calculation time onward. The discussion below provides a review of the literature related to this issue and provides an alternative dissipation rate constant value. Site specific dissipation rate constants can be used. This equation is for values of k that are greater than 0; when k=0, the dissipation term is not quantified to avoid division by zero. See the following text.

Based on many studies presented in EPA 2003 (pg. D-5), there is strong support for considering dissipation in setting criteria for building clean-ups. A study of the Binghamton State office Building found that dioxin has dissipated over time, according to first order kinetics, with a 20 to 22 month half-life. This dissipation is thought to occur from a combination of cleaning, resuspension, and dilution with uncontaminated dust (and possibly some volatilization). These same physical dissipation processes would apply to other compounds addressed in this study as well. Therefore, the other compounds were assumed to dissipate at the same rate as dioxin. In summary, a 22 month half-life (dissipation rate constant of  $0.38 \text{ yr}^{-1}$ ) was adopted. Exposures were calculated in a series of time steps, where the residue level was assumed to dissipate according to first order kinetics:

World Trade Center benchmark document, see pages D-5 to D-8 (which are attached in a pdf), below are some of the key text on how they set a dissipation rate at WTC. While after the WTC incident, there were interim benchmarks for dust outside they did not have any for final benchmarks so tracking new contamination indoors was not a problem.  
[https://archive.epa.gov/wtc/web/pdf/contaminants\\_of\\_concern\\_benchmark\\_study.pdf](https://archive.epa.gov/wtc/web/pdf/contaminants_of_concern_benchmark_study.pdf)

### 3.3 Dissipation

The surface loading of the contaminant in the dust is likely to diminish over the 30 year exposure period as a result of volatilization, chemical degradation, surface cleaning and transfers to skin/clothing. While some redeposition will also occur, the net long term effect should be a gradual decline. The discussion below provides a review of the literature related to this issue.

Several studies indicate that the main source of new dust indoors is track-in from footwear. Thatcher and Layton (1995) found a mass increase on tracked but not cleaned/vacuumed floor surfaces of 0.01 grams/day-m<sup>2</sup> for linoleum, 0.15 for upstairs carpet and 0.31 for downstairs carpet. They reported a value for the front doormat of 6.2 grams /day-m<sup>2</sup>. Allot (1992) also indicated that the main mechanism for introduction of dust indoors is tracking by footwear and noted a smaller contribution from deposition dust particles suspended in air. Without regular indoor cleaning the dust inputs would accumulate. With time, they would likely become noticeable or objectionable to the inhabitants, prompting cleaning. Lioy (2002) indicates that in a survey of 36 homes, an average time since the last cleaning was 14.2 days (range 1-150 days). Roberts et al. (1999) determined that the median value of dust loading on 11 carpets before cleaning was 1.3 g/m<sup>2</sup>. This agrees with Camann and Buckley's (1994) estimate of the

If cleaning occurred on a periodic basis as it normally does, newly tracked-in dust would continually be mixed with and removed by cleaning with dust in the carpet from previous tracking events. With continued cleaning eventually the dust reservoir (from past tracking events) would be replaced with newly tracked-in dust. This means that any initial, residual load of dust containing contaminants in a carpet would be gradually removed over time with periodic cleaning and no new significant input of contaminated dust. Roberts et al. (1999) determined that the residual lead loading in carpets could be reduced by 90 to 99% in 6 months by removing shoes on entering (lead was being tracked in from the outside), use of a doormat, and use of an efficient vacuum twice a week. They determined that vigorous vacuuming was efficient in removing the contaminated dust reservoir from carpets. If a carpet is initially loaded with a contaminated dust, a half-life for its removal can be calculated assuming 90% removal in 6 months using the Roberts et al. (1999) data. This results in a 2-month half-life for dust removal from carpets using vigorous cleaning by vacuuming. It would take roughly 12 months to reduce the initial contaminant load by 99.9% using the above scenario. With no new, significant inputs of contaminated dust to a carpet an initial, residual load would be reduced over time with regular vigorous cleaning.

The above analysis deals with a carpeted surface that can act as a dust reservoir and which is a difficult surface to clean. Non-porous surfaces such as floors and tables, etc. don't have the same degree of storage potential for dust and are easily cleaned. These surfaces will have a faster removal half-life than the approximately 2 months for carpets calculated above. However, they may get re-contaminated from dust re-suspension from the carpets (carpets become the source of contamination) until the carpet contaminant load is reduced.

Further data concerning the removal half-life of dioxins in indoor dust is available from the study of the Binghamton State Office Building (BSOB) (NYSDOH 2002). The building had closed in February 1981 after an intense transformer fire spread an oily soot contaminated with polychlorinated biphenyls (PCBs), polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) throughout the 18-story structure. After extensive decontamination, testing and reconstruction, the BSOB was reopened late in 1994. Pre-occupancy sampling in July 1994 found that PCB and PCDD/F levels in air and on surfaces in workspaces were considerably less than the guidelines set for reoccupancy. In fact, they were similar to levels found in buildings that have never experienced a transformer fire. Seven rounds of dust wipe sampling of tops of in-ceiling light fixtures were performed post-occupancy. PCDD/F levels on the tops of in-ceiling light fixtures averaged 1.1 nanograms per square meter at the final round of sampling, less than any previous measurements. The seven dust wipe sampling rounds indicated a gradual decline of PCDDs over-time on the light fixtures (see Figure 1). Since reoccupancy, surfaces above the ceiling were cleaned twice, once before the March 1997 sampling and again before the sixth round of sampling in August 1998. Since reoccupancy, average PCDD/F levels in dust on light fixtures have declined steadily by about one-half every 20-22 months (a half-life of 20-22 months).

Based on the above discussion, there is strong support for considering dissipation in setting criteria for building clean-ups. The recently completed study at the Binghamton State office Building described above found that dioxin has dissipated over time according to first order kinetics with a 20 to 22 month half life. As discussed above this dissipation is thought to occur from a combination of cleaning, resuspension and dilution with uncontaminated dust (and possibly some volatilization). These same physical dissipation processes would apply to other compounds addressed in this study as well. Therefore the other compounds were assumed to dissipate at the same rate as dioxin. Note that this leads to some overestimate of risk for the organic compounds with higher volatility than dioxin. In summary, a 22 month half life (decay rate constant of  $0.38 \text{ yr}^{-1}$ ) was adopted here and assumed to apply to all contaminants. Exposures were calculated in a series of time steps where the residue level was assumed to dissipate according to first order kinetics: